

## Earth and Environment

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Knowledge of the Earth and its environments is essential for successful stewardship of our home planet. The mission of FIU's Department of Earth and Environment is to be at the forefront of research and education about the dynamic interaction of Earth's systems, the environment, and related societal issues. Programs in the department address understanding and stewardship of the Earth. In addition, the department fosters understanding of the planet's bounty, with topics such as water, mineral, energy and agricultural resources. A third area of emphasis is environmental problems, both natural events such as

earthquakes, volcanic eruptions and floods, and human-made problems such as oil spills, ecosystem degradation and soil erosion. The department offers the Doctor of Philosophy Degree (Ph.D.) in Earth Systems Science, the Master of Science Degree (M.S.) in Geosciences, and the Master of Science (M.S.) in Environmental Studies.

## Doctor of Philosophy Degree in Earth Systems Science

The Ph.D. degree program offers concentration in either the geosciences with the Geosciences Major, or in environmental sciences, conservation, policy and management with the Natural Resource Science and Management Major. One of the two majors is chosen at the time of application in consultation with the student's prospective advisor, according to the emphasis of the student's research area. The Geosciences Major includes research on the solid Earth (structural geology, tectonics, igneous petrology, geochemistry, economic geology, and geophysics); Earth history, sedimentary rocks, and paleontology (stratigraphy, sedimentology, paleobiology, and paleoecology); Earth surface processes (hydrogeology, coastal geology, environmental biogeoscience, remote sensing and GIS applications, environmental geology, and geologic hazards); and atmospheric science (meteorology and climatology). The Natural Resource Science and Management Major includes research on the environmental sciences as related to environmental policy, conservation, and natural resource management. Overall, the doctoral program emphasizes a multidisciplinary approach to solving geoscientific and environmental problems, and stresses the importance of field observations complemented by laboratory analysis and numerical modeling.

### Application Procedures

Admission decisions to the Doctoral Program in Earth Systems Science will be made by the Department's Graduate Committee. To be considered for admission, applicants must submit the following documents prior to the admission deadlines.

1. FIU On-line Graduate Application Form (available at <https://admissions.fiu.edu/how-to-apply/graduate-applicant/index.html>).
2. Official transcripts of all college level work. When applicable, a certified English translation must accompany the original.
3. Graduate Record Examination and English proficiency (TOEFL and TSE) exam scores taken within the previous five years, sent from the Education Testing Service.
4. A resume with pertinent information regarding applicant's previous experience and achievements.
5. A statement of intent, including a brief discussion (not to exceed 2000 words) of educational goals and career projections, and the name of the prospective advisor. Applicants are urged to contact prospective advisors prior to application. The applicant may also include a copy of previous written scientific work.
6. Three letters of recommendation from former professors or academic advisors.
7. Official transcripts and test scores should be sent directly to the Office of Admissions, Florida

International University, P.O. Box 659004, Miami, FL 33265.

### Admission Requirements

To be admitted to the Doctoral Program in Earth Systems Science, a student must meet the following minimum requirements:

1. Hold a Bachelor's or Master's degree from an accredited college or university in a relevant discipline.
2. Have a grade point average (GPA) of 3.0 or higher (or equivalent) during the last two years of the undergraduate program, and 3.0 or higher during the Master's degree program.
3. Submit official Graduate Record Examination (GRE) scores.
4. International graduate student applicants whose native language is not English are required to submit a score for the Test of English as a Foreign Language (TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT (internet-based) TOEFL, 550 on the paper-based TOEFL, or 6.5 overall on the IELTS is required. A score of at least 50 on the Test of Spoken English (TSE) or 26 in the speaking section of the iBT TOEFL is required in order to be eligible for a teaching assistantship.
5. Meet the University's general requirements for admission to graduate programs. All application materials should be submitted by February 1 in order to be considered for Fall term admission and by August 1 for Spring term admission.

### Financial Aid

The Earth and Environment Department offers a number of graduate teaching and research assistantships which are awarded on a competitive basis. Teaching assistantships begin only in the fall semester. The assistantships provide a stipend and waiver of tuition. Applicants interested in an assistantship should indicate this in the FIU Graduate Application form and their cover letter. Applicants seeking assistantships should contact individual faculty members in their area of research interest.

### Course Requirements

The Doctor of Philosophy in Earth Systems Science is conferred based on satisfactory completion of required course work, a demonstrated mastery of a broad scope of knowledge, and the ability to conduct original and independent research. A minimum of 75 graduate-level credit hours is required. A minimum of 24 credit hours is devoted to research toward the Ph.D. Dissertation. A maximum of 36 graduate credit hours of formal lecture courses earned as part of a graduate degree from another accredited program may be transferred with the approval of the major advisor and Graduate Program Director.

ISC 5150	Introduction to Research in Earth and Environmental Sciences	2
ISC 5151	Earth and Environmental Graduate Seminar	1
ISC 6152	Earth and Environment Advanced Graduate Seminar	1
ISC 6153	Environments of a Changing Planet	3

GLY 6061	Geoscience Systems	3
EVR 6377	Natural Resource Conservation and Policy	3
GLY/EVR 7980	Ph.D. Dissertation	15

The remaining credits must include at least 12 credits of non-research, formal coursework. All coursework is selected in consultation with the major advisor. Natural Resource Science and Management majors should complete at least 18 credit hours in formal environmental coursework, so that upon graduation they can be certified as faculty members qualified to teach in that field.

### Graduation Requirements

1. A minimum GPA of 3.0 in all coursework is required for the Ph.D. degree.
2. Satisfactory performance on the Qualifying Examination covering general geoscientific and/or environmental knowledge and the field of specialization.
3. Successful presentation of a research proposal and oral examination before the Dissertation Committee, which together constitute the Candidacy Examination.
4. Completion and successful defense of a dissertation.

### Master of Science in Geosciences

This degree program offers opportunities for research in the same areas as for the Geosciences Major of the Ph.D. in Earth Systems Science (above). It emphasizes a multidisciplinary approach to solving geoscientific problems, stressing the importance of field observations complemented by laboratory analysis and numerical modeling. The application and admission procedures are also the same. Teaching assistantships are not available for the M.S. in Geosciences.

The Master of Science degree is conferred upon successful completion of the requirements (listed below) of either the Thesis Track or Non-Thesis Track option of the degree program.

#### Thesis Track: Course Requirements: 30 credits, including:

ISC 5151/ISC6152	Earth and Environment Graduate Seminar	2
	Courses in field of specialization	18
	Electives	4
GLY 6971	Thesis	6

Courses in the field of specialization and electives are chosen by the student in close consultation with a faculty advisor. These courses are selected to fit the student's particular professional goals and to ensure sufficient depth and breadth of geological knowledge.

#### Thesis Track: Graduation Requirements

1. A minimum GPA of 3.0 in all coursework counted toward the 30 credits is required for the Master's degree.
2. Satisfactory completion and defense of a thesis proposal and an original research thesis is required.

#### Non-Thesis Track: Course Requirements: 30 credits, including:

	Courses in field of specialization	18
	Electives	12

Electives for the non-thesis track may include at most 3 credits of Supervised Research (GLY 6910) leading to a research paper.

Doctoral candidates in the Geosciences Major who have filed the D-2 and D-3 forms and accepted by the University Graduate School can receive a Master of Science in Geosciences en route to the PhD after completion of 36 credits of graduate coursework with "non-thesis track" appearing in the transcript.

#### **Non-Thesis Track: Graduation Requirements:**

A minimum GPA of 3.0 in all course work counted toward the 30 credits is required for the Master's degree.

### **Combined BS/MS in Geosciences Degree Pathway**

The combined BS/MS degree pathway in Geosciences allows qualified students to earn both the BS in Geosciences and a non-thesis MS in Geosciences in a shorter amount of time than typically required for earning degrees sequentially. The accelerated pathway is designed for highly qualified undergraduate students in the Department of Earth and Environment.

To be considered for admission to the combined bachelor's/master's degree pathway, students must have completed at least 75 credit hours including all lower division requirements, typically have at least 30 credit hours remaining in the program and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree pathway; the application is submitted to Graduate Admissions typically before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree pathway will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Only 5000-level or higher courses, and no more than the number of credits specified by the program catalog, may be applied toward both degrees.

#### **Admission Requirements**

1. Current enrollment in the Bachelor of Science program in Geosciences at FIU.
2. Completed at least 75 credits of coursework (including UCC), and typically has 30 credits remaining.
3. Completion of all lower division required courses for the bachelors degree.
4. Minimum GPA of 3.2.
5. Official GRE scores.
6. Three letters of recommendation.
7. Approval by the Earth and Environment Graduate Committee.

#### **General Requirements**

1. Meet the requirements of both the BS and non-thesis MS degree in Geosciences.
2. Overlap of programs: Up to 3 courses (9 credits) may be used in satisfying **both** the BS and MS degree requirements, which must be at the 5000-level or higher.

### **Fields of Concentration in the Geosciences Major of the Ph.D. in the Earth Systems Science and the M.S. Geosciences**

#### **Atmospheric Sciences**

Researchers focus on hurricane dynamics, hurricane impacts, hurricane boundary layer turbulence structures, atmospheric convection, atmospheric boundary layer and clouds, and cloud-climate feedbacks.

#### **Environmental Biogeoscience**

Research in this concentration applies knowledge of biological, geological, physical, and chemical processes to current threats facing the biosphere, including deteriorating water and air quality, loss of biodiversity and ecosystem function, soil degradation, coastal erosion, and other emerging issues at local or global scales.

#### **Geophysics/Paleomagnetism/Remote Sensing**

Geophysical investigative techniques using gravity, magnetism, seismic reflection and refraction, earthquake seismology, thermal properties, and satellite imagery. Land-based geophysical studies of the Caribbean and South American seismicity and crustal structure. Environmental geophysical studies in the South Florida and Caribbean regions.

#### **Hydrogeology/Environmental Geology**

Field and modeling approaches to groundwater flow and solute fluxes in subsurface and near subsurface environments. Interaction of surface water and groundwater, solute transport, chemical and isotopic tracing techniques, watershed hydrology in Florida and beyond.

#### **Igneous Petrology/Geochemistry/Economic Geology**

Research problems in petrology/geochemistry of igneous and metamorphic rocks with reference to their origin, and relationships in time and space. Origin of hydrothermal and other economic deposits. Field occurrence, geochemistry and petrogenesis of crystalline rocks, forming the continental crust and seafloor. Generation of associated (often, economically significant) hydrothermal deposits. Application of trace element and isotope geochemistry to the study of these petrogenetic associations.

#### **Paleontology**

Research applied to taxonomy, phylogeny, evolutionary processes, paleoecology, taphonomy, and biostratigraphy of select microfossil groups. Research may address questions about biodiversity, biogeography, paleoecology, paleoenvironments, response to global climatic changes, and paleoceanography.

#### **Stratigraphy/Sedimentology**

Sedimentary petrology, sedimentary environments, paleoceanography, sequence stratigraphy, cyclic stratigraphy, microfacies analysis, and basin analysis. Field and laboratory techniques address evolution of sedimentary basins and their relationships to global and regional tectonics and paleoceanographic change.

#### **Structural Geology – Tectonics**

Field-oriented research on methods of structural analysis. Analysis of geologic deformation based upon the principles of mechanics and utilizing research data from

laboratory and field investigations of folding, fabrics, fracture, and faulting. Structural geology of the Caribbean and South America.

### Fields of Concentration in the Natural Resource Science and Management Major of the Ph.D. in Earth Systems Science

#### Land and Aquatic System Science

Application of multidisciplinary science and research techniques to managing environmental problems and sustainable use of land and aquatic resources; understanding and quantification of fundamental physical, chemical, and biological processes operating on land and in water, soil and other environments.

#### Natural Resource Management

Study of the interactions between natural systems and human systems. Research and management problems in the fields of natural resource conservation, ecosystem restoration, agroecology, ecotoxicology, forestry, wildlife, fisheries, and coastal and marine resources.

#### Environmental Economics and Policy

Analysis of policy effectiveness in managing environmental pollution, sustainable development, energy resources, climate change, food and agriculture, community forests, and local, national and international conservation programs. Research methods in ecosystem service valuation, economic modeling, and ethnographic and other behavioral analyses.

### Master of Science in Environmental Studies

The Department of Earth and Environment offers the Master of Science (M.S.) in Environmental Studies degree to train students for work in the areas of environmental policy, natural resource science and management, and sustainable development. An emphasis of the program is the cultural and political milieu in which environmental issues of a region are embedded. The program is interdisciplinary in nature, and students are encouraged to take advantage of University-wide resources, programs, and courses in environmental issues, such as those in Public Administration, International Relations, Biology, Chemistry, Geosciences, Political Science, Economics, and Sociology/Anthropology.

The M.S. degree program offers two options: thesis track and non-thesis track. The thesis track involves rigorous, solutions-oriented scientific research into the functioning of environmental systems. This track is highly recommended for students who are coming directly from undergraduate programs and who are interested in doctoral research in the future. The non-thesis track is primarily designed for employed professionals who may want to enhance their careers and skills through additional academic training beyond their bachelor's degree and practical training through internships with agencies, corporations, non-profit organizations or academic institutions. It is not recommended for students who do not have job experience.

#### Admission Requirements

To be admitted into the Master's Program in Environmental Studies, a student must meet the University's graduate admission requirements and have:

1. Have a "B" average in upper level work and submit official GRE scores, which every candidate must take.
2. International graduate student applicants whose native language is not English are required to submit a score for the Test of English as a Foreign Language (TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT TOEFL or 6.5 overall on the IELTS is required.
3. Submit three letters of recommendation, a one-page statement of research interests, and a copy of all transcripts to University Graduate Admissions on or before February 1 for the Fall admissions and August 1 for the Spring admissions.
4. Receive approval of the departmental Graduate Program Committee.

#### Degree Requirements

The Master of Science in Environmental Studies requires 36 credits, including the specific requirements (listed below) of either the thesis-track or non-thesis track option of the degree program. A maximum of six credits of post-baccalaureate graduate coursework may be transferred from other institutions, subject to approval of the Graduate Committee. Particular courses will be determined by the student in consultation with the thesis advisory committee, faculty advisor, or the Graduate Program Director.

#### Thesis Track: Course Requirements

ISC 6153	Environments of a Changing Planet	3
EVR 6377	Natural Resource Conservation and Policy	3
ISC 5150	Introduction to Research in Earth and Environmental Sciences	2
ISC 5151/ ISC 6152	Graduate Seminar/Advanced Graduate Seminar	1
EVR 6971	Master's Thesis	6
	Research Methods or Analysis Course	3
	Electives	18
	Total Credits	36

The research methods course and electives are selected in consultation with student's thesis advisor. Elective courses fit the student's thesis research. Additional Master's Thesis, Thesis Research, or Graduate Independent Study up to a maximum total of 3 credits may also be applied as elective credit. A maximum of six credit hours may be taken at the 4000 level, and a minimum of six credit hours of electives must be taken in Environmental Studies or other departmental courses. Students must demonstrate a competency in Statistics (equivalent to two courses of undergraduate statistics, taken prior to the admission into the program, with a "B" or better grade in both courses, or one course of graduate statistics with a "C" or better grade in both courses). Additional course work may be recommended by the advisory committee.

#### Thesis Track: Graduation Requirements

A grade of 'B' or higher must be obtained in all core courses. A grade of 'C' or higher must be obtained in all courses, with a cumulative GPA of 3.0 or higher in the 36 credits. A thesis must be completed and successfully defended in consultation with the student's graduate thesis committee.

**Non-Thesis Track: Course Requirements**

ISC 6153	Environments of a Changing Planet	3
EVR 6377	Natural Resource Conservation and Policy	3
EVR 5907	Research and Independent Study	3
ISC 5151/ISC 6152	Graduate Seminar/Advanced Graduate Seminar	2
Quantitative Methods Course		3
Electives		22
Total Credits		36

The quantitative methods course and electives are selected in consultation with faculty advisor. Elective courses are chosen and to fit the student's particular professional interest and to ensure sufficient breadth and depth of environmental studies knowledge. Students carrying out research, internship or independent study for their non-thesis project should sign up for EVR 5907, but may not exceed 6 credits total. EVR 6970 and EVR 6971 will not count toward electives. A maximum of 6 credit hours may be taken at the 4000 level. A minimum of 12 elective credits must be taken in Environmental Studies or other departmental courses. All courses must be taken for letter grades.

Doctoral candidates in the Natural Resource Science and Management Major of the Earth Systems Science degree who have filed the D-2 and D-3 forms and accepted by the University Graduate School can receive a Master of Science in Environmental Studies en route to the PhD after completion of 36 credits of graduate coursework with "non-thesis track" appearing in the transcript.

**Non-Thesis Track: Graduation Requirements**

A grade of "B" or higher must be obtained in all core courses. A grade of "C" or higher must be obtained in other courses, with a cumulative GPA of 3.0 or higher in the 36 credits. A project (EVR 5907) must be completed under faculty supervision, and the project report must be presented as a part of the Graduate Seminar class. This work may be based on a specific field research, or internship of current occupation. A project is defined as a substantial analysis and proposal for change of real-world environmental problem.

**Graduate Concentrations for the Master of Science in Environmental Studies**

The Department of Environmental Earth and Environment currently offers graduate-level concentrations in several different areas. A list of electives for each of these concentrations can be obtained from the Department's Office.

**Professional Science Master's (PSM) in Environmental Policy and Management**

The Professional Science Master's degree in Environmental Policy and Management is an interdisciplinary program designed to prepare students for careers in local, state and national environmental organizations and agencies. This professional degree is meant primarily for working professionals who wish to pursue a Master's on an accelerated basis. Most of the formal coursework is offered on Saturdays, and some courses may be offered as hybrid or fully online sections. The curriculum offers students a wide range of

competencies within broader professional areas related to environmental policy and management.

**Admission Requirements**

To be admitted into the professional science master's program in EPM, a student must meet the University's graduate admission requirements and have:

1. A "B" average in upper level work, which every candidate must take. International graduate student applicants whose native language is not English are required to submit a score for the Test of English as a Foreign Language (TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT TOEFL or 6.5 overall on the IELTS is required.
2. Submitted three letters of recommendation, a one page statement of career interests, and a copy of all transcripts to the Graduate Program Director on or before March 1 for International students and May 1 for Domestic students for the Fall admissions.
3. Received approval of the departmental graduate program committee.

**Degree Requirements**

The PSM in Environmental Policy and Management consists of a total of 36 credits, including an internship and completion of an independent study. The program is to be completed in four semesters with a course load of 10 credits during the fall and spring semesters and 6 credits in the summer.

**Core Courses**

EVR 5355	Environmental Resource Policy	3
EVR 5320	Environmental Resource Management	3
EVR 6950	Graduate Seminar (3 semesters @ 1 credit each)	3
STA 6196	Statistics for Environmental Sciences	3

**Area Subjects**

EVR 5409	Advanced Conservation Biology	3
EVR 5215	Water Resources Assessment	3
GIS 5050	Environmental GIS	3
EVR 7322	Methods in Sustainable Resources Management	3
EVR 7445	Public Lands Management	3
MMC 5655	Mass Communication and the Environment	3
EVR 5907	Research and Independent Study*	6

**Course Schedule****Semester 1 (Fall)**

EVR 5320	Environmental Resource Management	3
STA 6196	Statistics for Environmental Sciences	3
GIS 5050	Environmental GIS	3
EVR 6950	Graduate Seminar 1	1

**Semester 2 (Spring)**

EVR 5355	Environmental Resource Policy	3
EVR 5409	Advanced Conservation Biology	3
EVR 5215	Water Resources Assessment	3
EVR 6950	Graduate Seminar 2	1

**Semester 3 (Summer)**

EVR 5907	Research and Independent Study*	6
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**Semester 4 (Fall)**

EVR 7322	Methods in Sustainable Resource Management	3
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EVR 7445	Public Lands Management	3
MMC 5655	Mass Communication and the Environment	3
EVR 6950	Graduate Seminar 3	1

### Internship and Study Report

Students are required to complete a minimum of 6 credits as a laboratory or field internship during the summer semester of the program. During this time, they will work on a relevant, management-related project that has been mutually agreed upon by the employer and a faculty advisory committee. Students will be required to write a report on this project and present it orally as part of the final cumulative examination held at FIU. The student's advisory committee shall consist of the faculty sponsor and at least two additional committee members who have expertise in environmental science and/or the natural sciences.

### Graduation Requirements

A grade of "B" or higher must be obtained in all core courses. A grade of "C" or higher must be obtained in other courses, with a cumulative GPA of 3.0 or higher in the 36 credits. A project (EVR 5907) must be completed under faculty supervision, and the project report must be presented as part of the Graduate Seminar class (EVR 6950). This work may be used based on a specific field research, or internship of current occupation. A project is defined as a substantial analysis and proposal for change of real-world environmental problem.

### Combined BS/MS or BA/MS in Environmental Studies Degree Pathway

The combined BS/MS or BA/MS degree pathway in Environmental Studies allows qualified students to earn both the BS in Environmental Studies or the BA in Sustainability and the Environment and a non-thesis MS in Environmental Studies, in a shorter amount of time than typically required for earning degrees sequentially. The accelerated pathway is designed for highly qualified undergraduate students in the Department of Earth and Environment.

To be considered for admission to the combined bachelor's/master's degree pathway, students must have completed at least 75 credit hours including all lower division requirements, typically have at least 30 credit hours remaining in the program, and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree pathway; the application is submitted to Graduate Admissions typically before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree pathway will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Only 5000-level or higher courses, and no more than the number of credits specified by the program catalog, may be applied toward both degrees.

### Admission Requirements

1. Current enrollment in the Bachelor's Degree Program in Environmental Studies or Sustainability and the Environment at FIU.

2. Completed at least 75 credits of coursework (including UCC), and typically has at least 30 credits remaining.
3. Completion of all lower division required courses for the Bachelor's degree.
4. Current GPA of 3.25 or higher.
5. Official GRE scores.
6. Three letters of recommendation.
7. Approval by the Earth and Environment Graduate Committee.

### General Requirements

1. Meet the requirements of both the BS in Environmental Studies or BA in Sustainability and the Environment and the non-thesis MS degree in Environmental Studies.
2. Overlap of programs: Up to 3 courses (9 credits) may be used in satisfying **both** the BA/BS and MS degree requirements, which must be at the 5000-level or higher.

### Juris Doctor/Master of Science in Environmental Studies Joint Degree Pathway

The faculties of the College of Law and the College of Arts, Sciences and Education at Florida International University offer a joint degree pathway culminating in both a Juris Doctor (J.D.) degree, awarded by the College of Law, and a Master of Science in Environmental Studies (MS-ES) degree, awarded by the College of Arts, Sciences and Education. Under the joint degree pathway, a student can obtain both degrees in significantly less time than it would take to obtain both degrees if pursued consecutively. Essential criteria relating to the joint degree pathway are as follows:

1. Candidates for the pathway must meet the entrance requirements for and be accepted by both Colleges. Both Colleges must be informed by the student at the time of application to the second program that the student intends to pursue the joint degree.
2. The joint degree pathway is not open to students who have already earned one degree.
3. For law students, enrollment in the MS-ES program is required no later than the completion of 63 credit hours in the J.D. program. For MS-ES students, enrollment in the J.D. program is required no later than the completion of 24 credit hours in MS-ES program.
4. A student must satisfy the curriculum requirements for each degree before either degree is awarded. For the MS-ES degree, students must meet the requirement of the non-thesis track option. The College of Arts, Sciences and Education will allow 6 credit hours of foundation law courses and up to 9 credit hours of upper level environmental law courses to be credited toward both the MS-ES and J.D. degrees. These law classes will count toward the non-EVR Environmental Studies elective credits allowed under the MS-ES non-thesis track program. Reciprocally, law students may receive 9 hours of credit toward the satisfaction of the J.D. degree for courses taken in the MS-ES curriculum upon completion of the MS-ES degree curriculum with a grade point average of 3.0 or higher.

5. The College of Arts, Sciences and Education will recognize any significant, environment-related law review or research project completed with a letter grade of 'B' or better for the J.D. program toward the 3 credit hour course, EVR 5907 Research and Independent Study and the attendant 'Project' required for the MS-ES non-thesis track program. For the purpose of this program, a Project is defined as a substantial analysis and proposal for change of a real-world environmental problem, and requires preparation of a report and presentation as part of the required Environmental Studies Graduate Seminar class.
6. A student enrolled in the joint degree pathway may begin the student's studies in either College, but full time law students must take the first two semesters of law study consecutively and part-time law students must take the first three semesters of law study consecutively. Students admitted to one College but electing to begin study in the other College under the joint degree pathway may enter the second College thereafter without once again qualifying for admission so long as they have notified the second College before the end of the first week of the first semester in the second College and are in good academic standing when studies commence in the second College.
7. A student enrolled in the joint degree pathway will not receive either degree until the student has satisfied all of the requirements for both degrees, or until the student has satisfied the requirements of one of the degrees as if the student had not been a joint degree candidate.
8. As non-thesis track MS-ES students, students in the joint degree pathway will not normally be eligible for the graduate teaching assistantships in the Environmental Studies Department.

## Course Descriptions

*Note:* Laboratories may not be taken prior to the corresponding lecture course. Laboratories must be taken concurrently where noted, but students must register for the laboratory separately.

### Definition of Prefixes

AGR-Agronomy; ESC-Earth Science; EVR-Environmental Studies; EVS-Environmental Science; GIS-Geography; Information Science; GLY-Geology; ISC-Interdisciplinary Science/Natural Science; MET-Meteorology; OCG-Oceanography-Geological; SWS-Soil and Water Sciences F-Fall semester offering; S-Spring semester offering; SS-Summer semester offering.

**AGR 5241 Advance Modern Crop Production (3).** An advance course in agronomy applying crop, soil, and environmental sciences in understanding agricultural systems in the world. Includes the concepts of plant, seed, water, soil, tillage, pest, post harvest, ecophysiology, and sustainable aspects of crop production.

**AGR 6251 Sustainable Farming Systems (3).** Analysis of sustainability of modern agricultural farming systems under a variety of ecological economic and cultural settings.

**AGR 6255 Ecological Agriculture (3).** Application of ecological principles to modern farming systems to achieve goals of long-term food production without depleting Earth's resources.

**ESC 5005 Earth Science Enrichment Activities for Teachers (1-2).** Workshop presenting Earth Science enrichment activities to high school and middle school science teachers.

**EVR 5006 Environmental Science and Sustainability (3).** Introductory environmental science course for graduate students in environmental studies and other disciplines. Emphasizes physical sciences and applications to environmental issues.

**EVR 5044 Advanced GIS and Environmental Data Analysis (3).** Explores project planning, geospatial database design and implementation of analytical and display methods in GIS for organizing, querying, analyzing and presenting spatial data. Prerequisites: One of the following: EVR 5050, CGN 4321, CGN 5320, INR 4931, URS 6930.

**EVR 5061 South Florida Ecology: Field Studies (3).** Introduction to ecology of South Florida. Series of field trips to unique ecosystems (Everglades, hardwood hammocks, coastal regions). No science background required. Intended for teachers. Not intended for Environmental Studies graduate students.

**EVR 5065 Ecology of Costa Rican Rainforest (3).** Intensive study of Central American tropical forest ecosystems conducted for two weeks in Costa Rica in sites ranging from lowland to high mountains. Primarily for teachers. Prerequisites: Graduate standing or permission of the instructor. (SS)

**EVR 5066 Ecology of the Amazon Flooded Forest (3).** Study of the ecology of the flooded forest with emphasis on the relationships between plants and animals and the annual flooding cycle. The course includes a two-week field study at river camp in Peru. Prerequisites: Graduate standing or permission of the instructor. (SS)

**EVR 5069 Wetland Ecology and Management (3).** Principles of ecology and management as applied to freshwater and estuarine wetlands. Prerequisites: Undergraduate degree in science, or PCB 3043, or permission of the instructor.

**EVR 5122 Natural Disasters and Social Vulnerability (3).** Natural Disasters and Social Vulnerability course will introduce basic concepts and analytical tools of societal responses in managing natural disasters.

**EVR 5219 Water Resources Assessment (3).** Elements of hydrological cycle, hydrological processes and water resources assessment with emphasis on surface and groundwater water quantity and quality evaluation is central to the course.

**EVR 5236 Air Pollution Dynamics (3).** A course designed to give an understanding of the fates of atmospheric pollutants. Scavenging processes in the atmosphere; radiation, residence times, chemical reactions, global transport process, point source dispersion and modeling calculations. Prerequisites: EVS 3360 or EVR 4231.



**EVR 5313 Renewable Energy Sources (3).** An analysis of renewable energy sources and energy efficiency including wind, biomass, geothermal, hydroelectric, solid waste, solar heating, solar cooling, and solar electricity. Prerequisite: Permission of the instructor.

**EVR 5315 Energy Resources and Systems Analysis (3).** Detailed analysis of energy flows in natural and manmade systems. Energy systems analysis. Energy use patterns. Conventional and alternate sources of energy.

**EVR 5320 Environmental Resource Management (3).** The scientific and philosophical basis for the management of renewable and non-renewable energy, mineral, air, water, and biotic resources. Prerequisites: Graduate standing or permission of the instructor. (F)

**EVR 5332 Integrated Solutions for Water in Environment and Development (3).** Examines the theory and practice of integrated water resources management, focusing on science, policy, and socioeconomic themes evaluated through case studies from different regions of the world. Emphasis given to environmental elements.

**EVR 5353 International Energy Policy (3).** Focuses on the distribution of global energy resources and related issues. A comparison of the energy policies of various countries serves as the basis for exploring alternative energy policy approaches. Prerequisites: EVR 5355 or permission of the instructor.

**EVR 5355 Environmental Resource Policy (3).** A survey of international and national environmental policy and the legal, economic, and administrative dimensions of international accords and selected U.S. law. Prerequisites: EVR 5320 or permission of the instructor. (S)

**EVR 5360 Protected Area Management (3).** Explores historical, ecological, legal and socioeconomic aspects of the management of natural areas using examples worldwide. Prerequisite: Graduate standing in Environmental Studies or permission of instructor

**EVR 5375 Advanced Restoration Ecology (3).** Restoration planning, endangered species reintroduction, disturbed land reclamation, ecosystem restoration, challenges of climate change on ecological restoration. Prerequisite: One course or more in ecology.

**EVR 5376 Advanced Ecology and Management of Invasive Species (3).** An in depth study of the key ecological, social, and management questions surrounding introduced invasive species.

**EVR 5406 Endangered Species Policy and Management (3).** Exploration of the history of the U.S. Endangered Species Act, and its implementation and effectiveness through the listing and recovery planning processes. Prerequisite: Graduate standing in Environmental Studies or Biology, or permission of instructor.

**EVR 5409 Advanced Conservation Biology (3).** Exploration of modern applications of ecology, genetics and evolutionary biology in the conservation biology. Policy aspects of biological conservation are also discussed. Prerequisites: BSC 2010 and BSC 2011.

**EVR 5907 Research and Independent Study (VAR).** The student works with a professor on a research project. Variable credit.

**EVR 5935 Special Topics (VAR).** A graduate-level course dealing with selected environmental topics. The content will not necessarily be the same each time the course is offered.

**EVR 5936 Topics in Environmental Studies (3).** An analysis of several current environmental topics. Recommended for primary and secondary school teachers.

**EVR 6067 Tropical Forest Conservation and Utilization (3).** Distribution and classification of tropical forest ecosystems, their description and the ecological principles governing their function. Factors influencing tropical forest utilization and destruction, and strategies for sustainable use and conservation. Prerequisites: EVR 5355 or permission of the instructor.

**EVR 6268 Remote Sensing in Hydrology (3).** Sensors, platforms, satellites; image rectification, classification; data assimilation and parameterization; soil moisture, rainfall, discharge, evapotranspiration measurement, modeling and validation. Prerequisites: GLY 5754 or equivalent or permission of the instructor and EVR 5219 or EVR 4211 or equivalent or permission of the instructor.

**EVR 6300 Topics in Urban Ecology (3).** Topics include urban and suburban ecosystems emphasizing energy relations, ecological functions of urban landscapes, urban wildlife, urban forestry and ecological issues relevant to human health and well-being. Prerequisites: PCB 3043 or permission of the instructor.

**EVR 6330 Tropical Ecosystems Management (3).** Analyzes the dimensions of tropical ecosystems management. Organizational and institutional dynamics of the management of tropical forests, agriecosystems, and coastal areas are covered. Prerequisite: Permission of the instructor.

**EVR 6377 Natural Resource Conservation and Policy (3).** Interdisciplinary course focusing on diverse conservation issues and policy aspects of managing and conserving natural resources.

**EVR 6405 International Biological Conservation Accords (3).** Survey of international biological conservation agreements. Topics include bilateral migratory wildlife agreements, the Berne Convention on Migratory Wildlife, CITES, Ramsar, the UNCED Biodiversity Treaty and the Statement of Principles on Forests. Prerequisites: EVR 5355 or permission of the instructor.

**EVR 6950 Graduate Seminar (1).** A weekly seminar that features guest speakers, student presentations, and discussions among graduate students and faculty. Environmental Studies graduate students are required to register during three semesters of their program. Prerequisite: Permission of the instructor.

**EVR 6970 Supervised Research (1-12).** Supervised research toward completion of the student's program of study. Repeatable. Prerequisite: Permission of Major Professor.

**EVR 6971 Master's Thesis (1-12).** Completion of Master's Thesis. Repeatable. Prerequisite: Permission of Major Professor.



**EVR 7056 GIS in Water Resources (3).** Spatial analysis of watersheds and modeling of hydrological processes with emphasis on surface runoff, evapotranspiration and sub surface flow. Prerequisite: GIS 5050 or equivalent or permission of the instructor.

**EVR 7084 Interdisciplinary Environmental Studies (3).** Explores theoretical and practical approaches to interdisciplinary analysis of environmental issues, including sustainability science, ecological economics, and human-nature interactions. Prerequisites: EVR 5320 and EVR 5355 or equivalent or permission of the instructor.

**EVR 7322 Methods of Sustainable Resource Management (3).** A study of methods and policies for achieving a sustainable environment. Covers project appraisal, resource modeling and national accounts in the context of resource sustainability. Prerequisites: Graduate standing or permission of the instructor.

**EVR 7329 Watershed Analysis and Management (3).** An examination of the watershed approach to managing water and land resources. Integrating fundamental physical, chemical, and biological processes with human systems at the landscape scale using GIS.

**EVR 7445 Public Land Management (3).** Examines the historical, administrative, and legal settings that have predisposed various resource management agencies to succeed or fail in protecting public lands. Explores new and integrated approaches to building consensus on public land management issues. Prerequisites: EVR 5320, EVR 5355, equivalent or permission of the instructor.

**EVR 7980 Ph.D. Dissertation (1-15).** Research directed towards completion of the doctoral dissertation. To be taken every semester by the candidates if the Ph.D. Prerequisite: Permission of the major professor.

**EVS 6145 Ecotoxicology (3).** Fate of chemicals and their acute and chronic toxicological effects on aquatic and wildlife systems. Dose-response relationships, bioavailability, bioconcentration, microbial degradation, and biomonitoring. Prerequisites: One year of biology and one year of chemistry and CHM 2200 and lab or permission of the instructor.

**EVS 6194 Applied Soil Biology (3).** Examines biology of soil organisms and biologically-mediated chemical transformations occurring in soil ecosystems. Prerequisite: BSC 2011.

**EVS 6637 Ecological Risk Assessment (3).** Evaluation of risks of foreign chemicals to aquatic and terrestrial systems. Concepts and methodology used in the hazard and risk assessment of toxic effluents, chemical/oil spills, and contaminated sediments. Prerequisites: One year of biology and one year of chemistry and CHM 2200 and lab or permission of the instructor.

**GIS 5050 Environmental GIS (3).** Concepts of GIS, database design and management, advanced spatial analysis and modeling, uncertainty, error, and sensitivity in GIS. Focus on GIS project design, execution and presentation using ArcGIS. Prerequisite: Permission of the instructor.

**GLY 5021 Earth Sciences for Teachers (3).** Study of geological materials and processes, as covered in Physical Geology, but at a higher level and with additional

assignments. Prerequisite: Permission of the instructor. (F,S,SS)

**GLY 5060 Planet Earth: Dynamic Earth (1).** Essentials of metamorphism, rock rheology, seismology, plate tectonics, plate boundaries, plate movement, continental rifting and evolution of mountain belts.

**GLY 5107 Planet Earth: Evolving Earth (1).** Essentials of lithostratigraphy, biostratigraphy, geologic time scale, modern sedimentological processes, sedimentary rocks, evolution and extinction events, paleoenvironments and paleoclimates.

**GLY 5108 Paleoenvironments (3).** Sedimentary environments, paleoecology of fossils, skeletal mineralogy, marine paleoenvironmental changes, global patterns of change through time. Prerequisite: Permission of the instructor.

**GLY 5158 Florida Geology (3).** Detailed lithostratigraphic and biostratigraphic analyses of Southeast Florida and their relationship to tectonics, paleoclimates. Prerequisites: GLY 4511 and GLY 4511L. (S in alternate years)

**GLY 5159 Planet Earth: South Florida (1).** Geology, water resources and geologic environments of South Florida.

**GIS 5190 Advanced geospatial measurement techniques in Earth and Environmental Sciences (3).** Students will learn state-of-the-art field measurement techniques used in Earth and Environmental Sciences that will prepare them to conduct advanced graduate research.

**GLY 5245 Water-Rock Interaction (3).** Survey of geochemical processes at the water-rock interface. Topics include absorption of inorganic and organic ions, colloid stability in groundwater, mineral dissolution and precipitation. Prerequisites: CHM 1046, MAC 3312, GLY 4822 or permission of the instructor.

**GLY 5246 Geochemistry (3).** **GLY 5246L Geochemistry Lab (1).** Origin of chemical elements and principles affecting their distribution in the solar system, solid earth and hydrosphere. Use of chemical data to solve geologic problems. Prerequisites: Physical Geology and General Chemistry. (S in alternate years)

**GLY 5266 Stable Isotope Biogeochemistry (3).** Application and theory of stable isotope approaches to biogeochemistry. Topics: Introduction to IRMS machines, C/N/O/H/S (biogeochem. processes), sampling/lab. prep., and recent advances. Prerequisites: One year of chemistry or permission of the instructor.

**GLY 5283C Application of ICPES in Geochemistry (3).** Determination of elemental abundances in rocks, soils, natural water using inductively coupled plasma emission spectroscopy (ICPES). Instrumental principles, sample selection and preparation methods and application of results to research. Prerequisites: CHM 1045, CHM 1046 or permission of the instructor. (S or SS)

**GLY 5286 Research Instrumentation and Techniques in Geology (3).** Survey of techniques and instrumentation used in geological research, including computing and data handling. Prerequisites: Graduate standing or permission of the instructor. Corequisite: GLY 5286L. (F)

**GLY 5286L Research Instrumentation and Techniques in Geology Lab (1).** Introduction to advanced instrumentation and analytical techniques in Geology, including computing and data processing. Prerequisites: Graduate standing or permission of the instructor. Corequisite: GLY 5286. (F)

**GLY 5287C Scanning Electron Microscopy with EDS Analysis (3).** Imaging and microanalysis of materials using SEM including EDS. Prerequisite: Permission of the instructor.

**GLY 5288C Electron Microprobe Microanalysis with EDS Analysis (3).** Imaging and analysis of geological and other materials using electron microprobe with EDS analysis. Prerequisite: Permission of the instructor.

**GLY 5298 Topics in Geochemistry (3).** Seminar covering current research in selected areas of low-temperature geochemistry: oceans and oceanic sediments; continental waters and sediments; hydrothermal systems. Prerequisites: GLY 5246 or permission of the instructor. (F)

**GLY 5322 Igneous Petrology and Geochemistry (3).** Presentation and discussion of current topics in igneous petrology and geochemistry in a seminar format. Prerequisite: Permission of the instructor. (S)

**GLY 5329 Planet Earth: Solid Earth (1).** Essentials of the formation and evolution of the crust mantle and core of the earth. Composition and physical properties. Generation of magmas, their geochemistry.

**GLY 5335 Metamorphic Geology (3).** Metamorphic mineralogy; characteristics of low, medium and high pressure metamorphic rocks; pressure-temperature determinations; metamorphic textures; modeling and determination of P-T-t paths. (F)

**GLY 5335L Metamorphic Geology Lab (1).** Petrographic examination of metamorphic rocks. (F)

**GLY 5346 Sedimentary Petrology (3).** Systematic study of sedimentary rocks. Special emphasis on genetical aspects, geochemistry, paleontology, mineralogy, and microfacies. Emphasizes microscopic study. Prerequisite: GLY 4551. Corequisite: GLY 5346L. (F in alternate years)

**GLY 5346L Sedimentary Petrology Lab (1).** Laboratory studies of sediments and sedimentary rocks with emphasis on microscopic analyses and geochemical techniques. Prerequisites: GLY 4551 and GLY 4551L. Corequisite: GLY 5346. (F in alternate years)

**GLY 5408 Advanced Structural Geology (3).** Advanced treatment of the theory of rock mechanics to solve problems of natural rock deformation. Prerequisites: GLY 4400, MAC 3413, or permission of the instructor. Corequisite: GLY 5408L. (S)

**GLY 5408L Advanced Structural Geology Lab (1).** Problem solving in theory of rock deformation. Experimental procedures in rock mechanics. Corequisite: GLY 5408. (S)

**GLY 5415 Caribbean Geology and Tectonics (3).** Integration of geologic and geophysical data to understand the evolution and present tectonic configuration of the Caribbean area. Prerequisite: Permission of the instructor.

**GLY 5425 Tectonics (3).** Properties of the lithosphere; plate kinematics and continental drift; characteristics of plate boundaries; mountain belts; formation of sedimentary basins. Prerequisites: GLY 1010, 1100, 4400, 4300, 3202 or permission of the instructor. (S)

**GLY 5457 Geophysical Data Analysis (3).** Computer analysis and modeling of geophysical data and digital images. Statistical description of data, linear inverse theory, digital signal and image processing. Computer exercises with MATLAB. Prerequisites: GLY 4450, MAP 2302, MAS 3105, PHY 2048, PHY 2049 or permission of the instructor. (F)

**GLY 5457L Analysis of Geophysical Data Lab (1).** Field and laboratory applications of geophysical techniques. Computer aided analysis and three-dimensional modeling of gravity and magnetic data. Prerequisites: GLY 4450, PHY 2048, PHY 2049, MAC 2311, MAC 2312, MAP 2302. Corequisite: GLY 5457. (F)

**GLY 5475 Exploration Geophysics (3).** New in depth review of geophysical methods used in exploration and environmental geophysics. Digital data processing; Seismic methods; potential fields; electrical and EM methods; ground penetrating radar. Prerequisites: MAC 2312, PHY 2049 or PHY 2054.

**GLY 5495 Seminar in Geophysics (3).** Detailed investigation of current geophysical techniques, including topics on instrument design. Prerequisites: GLY 5457 or permission of the instructor. (S)

**GLY 5497 Topics in Structural Geology and Tectonics (3).** Selected advanced topics in structural geology and rock deformation. Latest advances in crustal tectonics. Prerequisite: GLY 5408. (S)

**GLY 5518 Advanced Stratigraphy (3).** Principles of stratigraphy and the geologic time scale applied to the sedimentary rock record, to determine dynamics of sedimentation, depositional environments and correlation. Prerequisite: Permission of the instructor. Corequisite: GLY 5518L.

**GLY 5518L Advanced Stratigraphy Laboratory (1).** Training in laboratory techniques to analyze sedimentary rocks for depositional reconstruction and correlation. Prerequisite: Permission of the instructor. Corequisite: GLY 5518.

**GLY 5593 Topics in Paleoclimatology (3).** Broad concepts in paleoclimatology are reviewed and discussed. Topics include climate models, Quaternary climates, dating and pre-Quaternary climates. Prerequisite: Permission of the instructor.

**GLY 5599 Seminar in Stratigraphy (3).** Discussion of research projects and/or current literature in stratigraphic correlation as derived from sedimentologic principles and biozonation. Prerequisite: GLY 5346. (F,S)

**GLY 5608 Advanced Paleontology I (3).** Discussion of current literature and research projects on evolution, systematics functional morphology, with reports by members of the seminar. Prerequisites: GLY 4603 or permission of the instructor. (F)

**GLY 5621 Caribbean Stratigraphic Micropaleontology (3).** Microscopic study of biostratigraphic type sections from the Caribbean area. Emphasis on planktonic

foraminifera and radiolaria, paleoecologic and paleoclimatic interpretations. Prerequisites: GLY 4603 or permission of the instructor. (F)

**GLY 5627 Workshop: Microfossil Paleoenvironments (2).** Recent foraminifera and diatoms are sampled, prepared and identified from marine to freshwater facies. Taxon distributions are used to interpret paleoenvironments.

**GLY 5628 Radiogenic Isotope Methods (3).** Theory and practice of radiogenic isotope ratio measuring techniques. Use of class-100 clean room facilities, and introduction to thermal ionization mass spectrometry. Prerequisite: General Chemistry.

**GLY 5655 Topics in Paleobiology (1-3).** Various concepts in paleobiology are reviewed and discussed, based on readings of the literature, including journal articles and books. Course may be repeated for credit with change in content. Prerequisite: Permission of the instructor.

**GLY 5710 Watershed Hydrology (3).** Hydrologic processes on watershed, water budgets, effects on water quality, field investigative methods using tracers and hydrometric measurements, hydrologic and hydro-chemical models.

**GLY 5736 Marine Geology and Geochemistry (3).** Examination of ocean floor provinces and the evolution of Earth's ocean basins. Interpretation of the distribution and geophysical and geochemical characteristics of seafloor basalt and sediments. Prerequisite: Permission of the instructor.

**GLY 5737 Coastal Processes and Environments (3).** Focus on the physical processes that cause erosion and shape our coastlines and the consequences for human development and habitation of this dynamic landscape. Prerequisite: Permission of the instructor.

**GLY 5754 Applied Remote Sensing in the Earth Sciences (3).** Application of remote sensing and image analysis in the earth sciences; qualitative and quantitative satellite image and air photo interpretation. Emphasis is on use of computer processing packages. Prerequisites: GLY 1010 or permission of the instructor.

**GLY 5758 GIS and Spatial Analysis for Earth Scientists (3).** Application of GIS technology to spatial problems in the Earth Sciences. Topics include: spatial statistics, sampling theory, surface estimation, map algebra, and suitability modeling.

**GLY 5785 Caribbean Shallow-Marine Environments (3).** Field study of multiple tropical environments in the Caribbean area. Dynamic processes and coastal evolution in response to natural and human-induced changes.

**GLY 5786 Advanced Field Excursion (3).** A study of the geology of a selected region of the world followed by 10-12 day field trip in order to study the field relationships of the geologic features. Special emphasis is given to stratigraphic, structural and tectonic relationships of lithic package. Prerequisite: Permission of the instructor. (SS)

**GLY 5808 Mining Geology (3).** Application of theoretical models of ore formation to exploration and the use of geochemical and geophysical techniques in the search for ore deposits. Prerequisites: GLY 4300 and CHM 1046. (F)

**GLY 5816 Economic Geology (3).** Economically important metal deposits of sedimentary, igneous and hydrothermal origins and their geologic settings and characteristics. Prerequisites: GLY 1010, GLY 4300, CHM 1045, CHM 1046. (S)

**GLY 5826 Hydrogeologic Modeling (3).** Techniques used in modeling groundwater flow and solute transport in geologic systems. Case studies of significant aquifers. Prerequisites: GLY 5827, MAP 2302, or permission of the instructor. (S,SS)

**GLY 5827 Hydrogeology (3).** Physics of flow in geological media. Saturated and unsaturated flow, groundwater and the hydrologic cycle, estimating hydraulic parameters of aquifers, introduction to chemical transport. Prerequisites: GLY 1010, MAC 2312, and PHY 2053, or permission of the instructor. (F)

**GLY 5827L Hydrogeology Lab (1).** Laboratory, field, and computer exercises to complement GLY 5827. (F)

**GLY 5828 Chemical Hydrogeology and Solute Transport (3).** Quantitative analysis of hydrologic, geologic, and chemical factors controlling water quality and the transport and fate of organic and inorganic solutes in the subsurface. Prerequisite: GLY 5827. (S)

**GLY 5834 Field Hydrogeology (3).** Field methods in hydrogeology. Drilling, logging, wells, data loggers, hydraulic conductivity/transmissivity measurements, purging, field chemistry parameter measurements, sampling methods. Prerequisites: GLY 4822 or permission of the instructor.

**GLY 5835 Introduction to Lattice Boltzmann Methods (3).** The course will provide an introduction to Lattice Boltzmann methods for fluid dynamics simulation. Emphasis on multiphase fluids. Prerequisites: Programming skills, graduate standing, permission of the instructor.

**GLY 5875 Applications of Transmission Electron Microscopy (3).** An introduction to theory and practical use of the JEOL JEM-1200EX II, Transmission Electron Microscope. Students will learn to prepare specimens and use for digital recording of publishable images. Prerequisites: Graduate standing or permission of the instructor.

**GLY 5888 Coastal Hazards and Mitigation (3).** Focus on the processes responsible for tsunamis, storm surges, coastal erosion, land subsidence, sea level rise, etc. and their mitigation.

**GLY 5889 Geology for Environmental Scientists and Engineers (3).** Characterization of rocks and rock masses; geological maps; seismic hazards; weathering of rocks; hydrologic cycle; slope stability; coastal processes; geophysical techniques. Course includes field trips in the South Florida region. Prerequisites: CHM 1045, GLY 1010 or permission of the instructor.(S)

**GLY 6061 Geoscience Systems (3).** Description and history of the deep Earth, shallow Earth, Earth's surface and Earth's atmosphere that form one great dynamic system. Discussion of research, discoveries and debates from classic and current scientific articles.

**GLY 6159 Stratigraphy of the Circum Caribbean Region (4).** Detailed lithostratigraphic and biostratigraphic

analyses of Caribbean islands, Central America, northern South America and Caribbean basin. Prerequisites: GLY 5621 or permission of the instructor. (SS)

**GLY 6247 Geochronology and Radioactive Isotope Geochemistry (3).** Use of naturally-occurring radioactive and radiogenic isotopes to determine ages of earth events and rates of earth processes at timescales ranging from the recent past through the age of the earth. Prerequisites: GLY 5246 or permission of the instructor. (S)

**GLY 6328 Advanced Igneous Petrology (3).** Interpretation of igneous rocks; chemistry and physics of magma generation and crystallization; origin of major igneous rock series with emphasis on tectonic controls. Prerequisite: Permission of the instructor. Corequisite: GLY 6328L. (S)

**GLY 6328L Advanced Igneous Petrology Lab (1).** Identification of rocks using microscopic and microprobe techniques. Prerequisite: Permission of the instructor. Corequisite: GLY 6328. (S)

**GLY 6337 Metamorphic Phase Equilibria (3).** Theory and methods of calculation of metamorphic phase equilibria and P-T paths using appropriate analysis of composition space, activity models, geothermometry, geobarometry. Origin and interpretation of zoning in metamorphic minerals. Prerequisites: GLY 5335 or permission of the instructor. (F)

**GLY 6345 Sedimentary Petrography (3).** Comparative study and fundamental observations of sedimentary rocks in hand specimens and under the petrographic microscope; their classification, theoretical and practical implications. Prerequisites: GLY 4551 or permission of the instructor. (F)

**GLY 6345L Sedimentary Petrography Laboratory (1).** Laboratory studies of sedimentary rocks in thin section. Prerequisites: GLY 4551 or permission of the instructor. Corequisite: GLY 6345. (F)

**GLY 6353 Microfacies Analysis (3).** **GLY 6353L Microfacies Analysis Laboratory (1).** Identification and interpretation of the fossil and mineralogical constituents of sedimentary rocks in thin section. Emphasis is placed on the paleoecological significance of fossil remains in carbonates. Prerequisites: GLY 4551 or permission of the instructor. (S)

**GLY 6392 Topics in Igneous Petrology and Geochemistry (3).** Research seminar in contemporary petrology and geochemistry. Student presentation on thesis research. Prerequisites: GLY 5322 or permission of the instructor. (F,S)

**GLY 6427 Quantitative Geotectonics (3).** Application of continuum mechanics and heat transfer to problems in geology. Observational constraints on earth properties. Emphasis is on problems relating to the earth's lithosphere. Prerequisites: GLY 4450, GLY 4400, GLY 5425 and MAP 2302 or permission of the instructor. (F in alternate years)

**GLY 6444 Quantitative Analysis of Joints and Faults (3).** Application of fracture mechanics to geologic problems, including the analysis of local and regional stress fields, bedrock fracture systems, estimation of fracture related strain, and the influence of mechanical properties on rock failure. Prerequisites: GLY 4400, GLY

4450, GLY 5425 or permission of the instructor. (F in alternate years)

**GLY 6447 Advanced Topics in Structural Geology and Tectonics (3).** Detailed exploration of selected research topics in structural geology and tectonics. Prerequisites: GLY 5408 or permission of the instructor. (F,S)

**GLY 6448 Stress in the Earth's Crust (3).** The distribution and magnitude of stress in the earth's crust, laboratory derived values for earth stress, in situ stress measurements, regional stress patterns and sources of stress in the lithosphere. Prerequisites: GLY 4400, GLY 4450, GLY 5425 or permission of the instructor. (S)

**GLY 6468 Paleomagnetism (3).** Physics of rock and mineral magnetism, geomagnetism and paleomagnetism; field and laboratory methods, geomagnetic field behavior, magnetostratigraphy, apparent polar wander. Prerequisites: GLY 4400, GLY 3202 or permission of the instructor. Corequisite: GLY 6468L. (F)

**GLY 6468L Paleomagnetism Laboratory (1).** Physics of rock and minerals magnetism, geomagnetism and paleomagnetism; field and laboratory methods, geomagnetic field behavior, magnetostratigraphy, apparent polar wander. Prerequisites: GLY 4400, GLY 3202 or permission of the instructor. Corequisite: GLY 6468. (F)

**GLY 6485 Physics of the Earth (3).** Properties and dynamics of the Earth's interior studied from a physical perspective. Topics include heat flow, fluid flow, earthquake seismology. Prerequisites: GLY 4450 and MAC 2313. (F)

**GLY 6496 Advanced Topics in Geophysics (3).** Discussion of research projects and current literature in geophysics. Prerequisite: GLY 5495. (S)

**GLY 6517 Basin Analysis (3).** Analysis of sedimentary basins based on their origin, paleogeographic evolution and tectonic setting. Emphasis is placed on the tectonic evolution and economic potential of sedimentary basins. (S in alternate years)

**GLY 6517L Basin Analysis Lab (1).** Analysis of different types of sedimentary basins using a case history approach. Corequisite: GLY 6517. (S in alternate years)

**GLY 6595 Topics in Sedimentology (3).** Oral presentation by students of research projects and survey of relevant literature with reports by members of the seminar. Prerequisite: GLY 5346. (S in alternate years)

**GLY 6626 Stratigraphic Micropaleontology: Foraminifera (3).** Nomenclature, taxonomy, and biostratigraphy of Cretaceous and Cenozoic planktonic foraminifera. Studies of stratigraphically important taxa from Caribbean land sections, piston cores, and DSDP/ODP sites. Prerequisites: GLY 5621 or permission of the instructor. (F in alternate years)

**GLY 6627 Stratigraphic Micropaleontology: Radiolaria (3).** Nomenclature, taxonomy and biostratigraphy of Cretaceous and Cenozoic radiolaria. Studies of stratigraphically important taxa using Caribbean land sections, piston cores, and DSDP/ODP sites. Prerequisites: GLY 5621 or permission of the instructor. (S in alternate years)

**GLY 6628 Stratigraphic Micropaleontology: Calcareous Nannofossils (3).** Nomenclature, taxonomy,

and biostratigraphy of triassic to recent nannofossils. Intensive training of identification of marker taxa using land and DSDP/ODP sites. Prerequisites: GLY 5621 or permission of the instructor. (S in alternate years)

**GLY 6690 Topics in Paleontology (3).** Oral presentation and discussion of current research projects and relevant literature, with reports by members of the seminar. Prerequisites: GLY 5608 or permission of the instructor. (F)

**GLY 6809 Hydrothermal Geochemistry (3).** The mineralogy, thermodynamics, chemistry and isotope chemistry of hydrothermal and geothermal systems, with an emphasis on the transport of solutes in hydrothermal solutions and ore-forming processes. Prerequisites: GLY 5246, CHM 3400 or permission of the instructor. (S in alternate years)

**GLY 6817 Topics in Economic Geology (3).** Current research directions in Economic Geology and Geochemistry, including ore formation processes, exploration and remediation.

**GLY 6862 Numerical Methods in the Earth Sciences (3).** Numerical techniques used by geoscientists, with emphasis on finite-difference and finite-element techniques to solve equations governing fluid flow and mass transport in geological systems. Prerequisites: MAP 2302, GLY 5827 and knowledge of one programming language or permission of the instructor.

**GLY 6896 Advanced Topics in Hydrology (1-3).** Research-oriented seminar course involving analysis of several contemporary topics chosen from the current literature in hydrology. Specific topics vary. May be repeated. Prerequisites: GLY 5827 and one other graduate level hydrology/hydrogeology course, or permission of the instructor. (S in alternate years)

**GLY 6910 Supervised Research (1-12).** Research apprenticeship under the direction of a professor or a thesis advisor. Prerequisites: Full graduate admission and permission of the instructor.

**GLY 6941 Supervised Teaching in the Geosciences (1).** Teaching a geological discipline under the supervision of departmental faculty. Prerequisite: Graduate standing.

**GLY 6945 Proposal Writing (1).** A graduate course aimed at introducing students to grant proposal writing.

**GLY 6949 Professional Internship in Earth Science (1-3).** Semester or summer term of supervised work at an approved government or industry laboratory or field station. Prerequisite: Graduate standing.

**GLY 6966 Master's Comprehensive Examination (0).** Oral and written examinations on knowledge in general geology and the student's field of concentration. Schedule to be selected in consultation with the Graduate Committee. Prerequisite: Advanced graduate standing. (F,S,SS)

**GLY 6971 Master's Thesis (1-12).** Field and/or laboratory research project toward thesis. Selected in consultation with major professor. Prerequisite: Permission of the major professor. (F,S,SS)

**GLY 7980 Ph.D. Dissertation (1-12).** Field and/or laboratory research directed towards completion of the doctoral dissertation. Selected in consultation with major

professor. Prerequisite: Permission of the Major Professor and Doctoral Candidacy. (F,S,SS)

**ISC 5150 Introduction to Research in Earth and Environmental Sciences (2).** Introduction to research in Earth and Environmental Sciences: nature of scientific inquiry, development of research projects, data analysis, publication and presentation of research results.

**ISC 5151 Earth and Environmental Graduate Seminar (1).** Weekly seminar emphasizing research- and practice-oriented guest speaker series. Critical examination of current research topics by students, faculty, visiting speakers. Brief student reports. Prerequisite: Permission of the instructor.

**ISC 6152 Earth and Environment Advanced Graduate Seminar (1).** Weekly seminar emphasizing research- and practice-oriented guest speakers. Critical examination of current research topics by students, faculty, visiting speakers. Student research presentations. Prerequisite: ISC 5151.

**ISC 6153 Environments of a Changing Planet (3).** Interactions of physical, chemical and biological components and processes that have led to recent past and present environmental development, and possible future changes.

**ISC 6155 Supervised Teaching in Earth and Environment (1).** Instructional methods of teaching a course in an earth and environment discipline under the supervision of departmental faculty. Courses can include undergraduate laboratory courses. Prerequisite: graduate standing.

**MET 5016 Physics of Atmospheres I (3).** A quantitative examination of atmospheric radiation, thermodynamics and clouds, with a brief introduction to dynamics and applications to weather and climate. Prerequisites: Senior or first-year graduate student in physical science, computer science, or engineering.

**MET 5017 Physics of Atmospheres II (3).** Continuing examination of atmospheric dynamics, waves and instabilities, with applications to models, weather and climate. Prerequisites: Senior or first-year graduate student in physical science, computer science, or engineering.

**MET 5105 Planetary Climate Change: Processes and Impacts (3).** Interdisciplinary study of the reasons the Earth's climate is changing, the climates past and expected future variations, impacts on the human and natural environments, and ways to reduce them. Prerequisite: Graduate standing.

**MET 5135 Climate Dynamics (3).** Global energy cycle, atmospheric radiative transfer, surface energy balance, hydrologic cycle, atmosphere/ocean circulation, climate feedbacks, natural variability, anthropogenic climate change. Prerequisite: Graduate standing.

**MET 5305 Boundary Layer Meteorology (3).** General survey of boundary meteorology. Topics include atmospheric boundary layer, (ABL), role in exchange and circulation, use in interpreting wind, temperature, and moisture distribution, hurricane boundary layer wind, and turbulent structures. Prerequisites: PHY 2048 and PHY 2049.

**MET 5311 Dynamic Meteorology I (3).** To study atmospheric phenomena on a rotating planet. It intends to lead towards an understanding of the theories of the atmospheric motion by applying concepts of Math., thermodynamics, and dynamics. Prerequisites: PHY 2048, PHY 2049.

**MET 5312 Atmospheric Dynamics II (3).** Second graduate-level course in Atmospheric Dynamics. Topics include 2 and 3-dimensional Rossby waves, baroclinic and other instabilities, ageostrophic motions, and general circulation. Prerequisites: Atmospheric Dynamics I and graduate standing in Atmospheric Sciences.

**MET 5355 Severe and Hazardous Weather (3).** Focuses on introducing thunderstorms, squall lines, mesoscale convection systems, and their interactions with synoptic scale weather. Prerequisites: MET 3003 or permission of the instructor.

**MET 5365 Techniques for Earth System Modeling and Research (3).** Model development for meteorology, hydrology, and geophysics using Python and FORTRAN. Includes model formulation, architecture and approximations, and synthesis of results. Prerequisite: Permission of the instructor.

**MET 5412 Remote Sensing in Meteorology (3).** An overview of satellite and radar remote sensing including the principles of atmospheric radiative transfer, the retrieval of atmospheric variables, and basic principles of interpretation. Prerequisites: PHY 2048 and PHY 2049.

**MET 5525 Advanced Weather Forecasting (2).** Graduate-level forecasting to guide setting of watches and warnings. Includes map discussions, analysis of current weather, and prediction for aviation, severe weather, and flash floods. Prerequisite: MET 3502 and MET 3502L or MET 5561 and MET 5561L.

**MET 5530 Hurricane Meteorology and Impacts (3).** Hurricane formation, motion, and impacts on the graduate level. Adds critical reading of the scientific and disaster literatures and quantitative problem sets to the undergraduate experience. Prerequisite: Permission of the instructor.

**MET 5533L Weather Discussion and Analysis (1).** Focus on analysis and forecasting of middle-latitude and tropical weather systems. Students will be required to give weather forecast discussions and to work on a research project. Prerequisites or Corequisites: MET 3502 or permission of the instructor.

**MET 5561 Midlatitude Synoptic Meteorology (3).** Focus on analysis and forecasting of middle-latitude weather systems. Examine the structure and dynamic of these systems by integrating weather observation with the current state of dynamic theory. Prerequisites: MET 3003 or permission of the instructor.

**MET 5561L Midlatitude Synoptic Meteorology Lab (1).** Focus on analysis and forecasting of middle-latitude weather systems. Develop an understanding of the weather forecasting process, and gain experience in communicating weather forecasts. Prerequisites: MET 3003 or permission of the instructor.

**MET 5707 Operational Meteorology Research I (3).** Training at NOAA's Miami facilities, focusing in upper air observations, in preparation for careers in forecasting.

Offered for Pass/Fail only. Prerequisites: Graduate standing in Atmospheric Science and permission of the instructor.

**MET 5708 Operational Meteorology Research II (3).** Second semester training at NOAA's Miami facilities, focusing on use of AWIPS system and forecasting procedures, in preparation for careers in forecasting. Offered for Pass/Fail only. Prerequisites: MET 5707 and permission of the instructor.

**MET 6971 Thesis (1-12).** Individual graduate-level research supervised by a professor in the student's field of specialization or interest, leading toward a completed thesis. Prerequisites: Graduate standing in Geosciences and satisfactory progress toward the degree.

**MET 7980 Ph.D. Dissertation (1-9).** Continuing graduate-level research under the supervision of the student's advisor doctoral committee. Writing, revision, defense, and completion of a doctoral dissertation. Prerequisites: Graduate standing in Geosciences and satisfactory progress toward the doctoral degree.

**OCC 6413 Biogeochemistry of Estuaries and Coasts (3).** A survey of estuarine and coastal ecosystems with particular emphasis on how physical, geological, chemical, and biological processes act to regulate ecosystem function. Prerequisites: PCB 3043, EVR 3013 or equivalent.

**OCG 6105 Advanced Marine Geology (3). OCG 6105L Advanced Marine Geology Lab (1).** Application of geophysical and geological data to the interpretation of the earth's crust under the oceans, including the data provided by the Deep-Sea Drilling Project, dredging, piston-coring, gravity magnetism, and seismicity. Special emphasis will be given to the genesis and evolution of the Atlantic and Caribbean margins, and their potential for oil resources. Prerequisites: GLY 4730 or permission of the instructor. (F in alternate years)

**OCG 6664 Paleoceanography (3).** Mesozoic/Cenozoic development of the major ocean basins, their circulation and sedimentation history. Use of micropaleontologic and stable isotopic techniques in paleoceanographic analysis. Prerequisites: GLY 4730 or permission of the instructor. (F in alternate years)

**SWS 5305 Advanced Soil Resources Analysis (3).** A review of soil science concepts: analysis of physical and chemical properties of soils and nutrient cycling, emphasizing the soils of South Florida. Prerequisites: BSC 2010, BSC 2011, CHM 2210, CHM 2211; or permission of the instructor.